```matlab
% Apoorv Singh 2019151
% PCS Quiz-4 Problem-1

t = 0:0.01:3; %defining the time-axis
x_t = 5*sin(t) + 4*cos(t).*cos(t); %signal to be quantized

subplot(4,1,1)
stem(t, x_t, 'r', 'b.-', 'LineWidth', 0.5, 'MarkerSize', 10); %sampled
 signal
title('Sampled Signal')

arr1 = rand(1,301); %matrix to store the quantized values of the
 signal
arr2 = rand(1,17); %matrix to store the intervals used for
 quantization
arr3 = cell(1,16); %cell array to store bit values for 16-level
 quantizer
arr4 = cell(1,301); %cell array to store the encoded signal

for i = 1:16 %storing binary values in arr3
    arr3{i} = dec2bin(i-1,4);
end

for i = 1:17 %storing interval values in arr2
    arr2(1,i) = 4 + 0.0976*(i-1);
end

arr2(1,17) = 5.5625; %storing last interval value in arr2

for i = 1:301 %here we store the quantized values and encoded values
 in arr1 and arr4 respectively
    t_1 = (i-1)/100;
    for j = 1:16
        if((5*sin(t_1) + 4*cos(t_1)*cos(t_1)) >= arr2(1,j) &&
 (5*sin(t_1) + 4*cos(t_1)*cos(t_1)) <= arr2(1,j+1))
            arr1(1,i) = (arr2(1,j)+arr2(1,j+1))/2; %assigning
 quantized value
            arr4{i} = arr3{j}; %assigning encoded value
        end
    end
end

%The 'if' statement in the loop above checks in which interval the
 sampled
%value lies, so that it can be quantized and then encoded

disp('The dimension of the quantized matrix is 1X301. The matrix is
 given below')
disp(arr1)

disp('The encoded matrix is given below')
disp(arr4)
```

```matlab
subplot(4,1,2); %plotting quantized signal
plot(arr1, 'b', 'Linewidth', 3)
title('Quantized Signal')

arr_sig = rand(1,301); %here quantized signal is overlapped with input
 signal
for i = 1:301
    t_2 = (i-1)/100; %time axis of the input signal is changed here so
 that quantized signal can be overlapped with input signal
    arr_sig(i) = 5*sin(t_2) + 4*cos(t_2)*cos(t_2);
end
subplot(4,1,3)
plot(arr1, 'b', 'Linewidth', 3)
hold;
plot(arr_sig, 'g', 'Linewidth', 3)
title('Quantized signal overlapped on input signal')

bit_stream = ''; %Generating bitstream here
for i = 1:301
    bit_stream = append(bit_stream, arr4{i});
end

disp('Bitstream is given below')
disp(bit_stream)
disp('Length of bitstream is')
disp(strlength(bit_stream))

arr_pulse = rand(1,20); %arr_pulse is an array which stores the first
 20 pulses of the line code
for i = 1:20 %Using polar NRZ-encoding and plotting the line code
    if(bit_stream(i) == '0')
        arr_pulse(1,i) = 0;
    else
        arr_pulse(1,i) = 1;
    end
end

subplot(4,1,4) %plotting the line code
stairs([arr_pulse,arr_pulse(end)], 'black', 'Linewidth', 3)
title('Line-code plot')
```

*The dimension of the quantized matrix is 1X301. The matrix is given
 below*
  Columns 1 through 7

    4.0488   4.0488   4.1464   4.1464   4.1464   4.2440   4.2440

  Columns 8 through 14

    4.3416   4.3416   4.4392   4.4392   4.5368   4.5368   4.5368

  Columns 15 through 21

```
    4.6344      4.6344      4.7320      4.7320      4.7320      4.8296      4.8296

Columns 22 through 28

    4.8296      4.9272      4.9272      4.9272      5.0248      5.0248      5.0248

Columns 29 through 35

    5.1224      5.1224      5.1224      5.1224      5.2200      5.2200      5.2200

Columns 36 through 42

    5.2200      5.2200      5.3176      5.3176      5.3176      5.3176      5.3176

Columns 43 through 49

    5.4152      5.4152      5.4152      5.4152      5.4152      5.4152      5.4152

Columns 50 through 56

    5.5133      5.5133      5.5133      5.5133      5.5133      5.5133      5.5133

Columns 57 through 63

    5.5133      5.5133      5.5133      5.5133      5.5133      5.5133      5.5133

Columns 64 through 70

    5.5133      5.5133      5.5133      5.5133      5.5133      5.5133      5.5133

Columns 71 through 77

    5.5133      5.5133      5.5133      5.5133      5.5133      5.5133      5.5133

Columns 78 through 84

    5.5133      5.5133      5.5133      5.5133      5.5133      5.5133      5.5133

Columns 85 through 91

    5.5133      5.5133      5.5133      5.5133      5.5133      5.5133      5.4152

Columns 92 through 98

    5.4152      5.4152      5.4152      5.4152      5.4152      5.4152      5.4152

Columns 99 through 105

    5.4152      5.4152      5.4152      5.3176      5.3176      5.3176      5.3176

Columns 106 through 112

    5.3176      5.3176      5.3176      5.3176      5.3176      5.3176      5.3176
```

Columns 113 through 119

   5.2200   5.2200   5.2200   5.2200   5.2200   5.2200   5.2200

Columns 120 through 126

   5.2200   5.2200   5.2200   5.1224   5.1224   5.1224   5.1224

Columns 127 through 133

   5.1224   5.1224   5.1224   5.1224   5.1224   5.1224   5.1224

Columns 134 through 140

   5.1224   5.1224   5.0248   5.0248   5.0248   5.0248   5.0248

Columns 141 through 147

   5.0248   5.0248   5.0248   5.0248   5.0248   5.0248   5.0248

Columns 148 through 154

   5.0248   5.0248   5.0248   5.0248   5.0248   5.0248   5.0248

Columns 155 through 161

   5.0248   5.0248   5.0248   5.0248   5.0248   5.0248   5.0248

Columns 162 through 168

   5.0248   5.0248   5.0248   5.0248   5.0248   5.0248   5.0248

Columns 169 through 175

   5.0248   5.0248   5.0248   5.0248   5.0248   5.0248   5.0248

Columns 176 through 182

   5.0248   5.0248   5.0248   5.0248   5.0248   5.1224   5.1224

Columns 183 through 189

   5.1224   5.1224   5.1224   5.1224   5.1224   5.1224   5.1224

Columns 190 through 196

   5.1224   5.1224   5.1224   5.1224   5.2200   5.2200   5.2200

Columns 197 through 203

   5.2200   5.2200   5.2200   5.2200   5.2200   5.2200   5.2200

Columns 204 through 210

5.2200   5.3176   5.3176   5.3176   5.3176   5.3176   5.3176

Columns 211 through 217

    5.3176   5.3176   5.3176   5.3176   5.4152   5.4152   5.4152

Columns 218 through 224

    5.4152   5.4152   5.4152   5.4152   5.4152   5.4152   5.4152

Columns 225 through 231

    5.4152   5.5133   5.5133   5.5133   5.5133   5.5133   5.5133

Columns 232 through 238

    5.5133   5.5133   5.5133   5.5133   5.5133   5.5133   5.5133

Columns 239 through 245

    5.5133   5.5133   5.5133   5.5133   5.5133   5.5133   5.5133

Columns 246 through 252

    5.5133   5.5133   5.5133   5.5133   5.5133   5.5133   5.5133

Columns 253 through 259

    5.5133   5.5133   5.5133   5.5133   5.5133   5.5133   5.5133

Columns 260 through 266

    5.5133   5.5133   5.5133   5.5133   5.5133   5.5133   5.5133

Columns 267 through 273

    5.4152   5.4152   5.4152   5.4152   5.4152   5.4152   5.4152

Columns 274 through 280

    5.3176   5.3176   5.3176   5.3176   5.3176   5.2200   5.2200

Columns 281 through 287

    5.2200   5.2200   5.2200   5.1224   5.1224   5.1224   5.1224

Columns 288 through 294

    5.0248   5.0248   5.0248   4.9272   4.9272   4.9272   4.8296

Columns 295 through 301

    4.8296   4.8296   4.7320   4.7320   4.7320   4.6344   4.6344

The encoded matrix is given below
  Columns 1 through 6

    {'0000'}   {'0000'}   {'0001'}   {'0001'}   {'0001'}
{'0010'}

  Columns 7 through 12

    {'0010'}   {'0011'}   {'0011'}   {'0100'}   {'0100'}
{'0101'}

  Columns 13 through 18

    {'0101'}   {'0101'}   {'0110'}   {'0110'}   {'0111'}
{'0111'}

  Columns 19 through 24

    {'0111'}   {'1000'}   {'1000'}   {'1000'}   {'1001'}
{'1001'}

  Columns 25 through 30

    {'1001'}   {'1010'}   {'1010'}   {'1010'}   {'1011'}
{'1011'}

  Columns 31 through 36

    {'1011'}   {'1011'}   {'1100'}   {'1100'}   {'1100'}
{'1100'}

  Columns 37 through 42

    {'1100'}   {'1101'}   {'1101'}   {'1101'}   {'1101'}
{'1101'}

  Columns 43 through 48

    {'1110'}   {'1110'}   {'1110'}   {'1110'}   {'1110'}
{'1110'}

  Columns 49 through 54

    {'1110'}   {'1111'}   {'1111'}   {'1111'}   {'1111'}
{'1111'}

  Columns 55 through 60

    {'1111'}   {'1111'}   {'1111'}   {'1111'}   {'1111'}
{'1111'}

  Columns 61 through 66

```
    {'1111'}    {'1111'}    {'1111'}    {'1111'}    {'1111'}
{'1111'}

  Columns 67 through 72

    {'1111'}    {'1111'}    {'1111'}    {'1111'}    {'1111'}
{'1111'}

  Columns 73 through 78

    {'1111'}    {'1111'}    {'1111'}    {'1111'}    {'1111'}
{'1111'}

  Columns 79 through 84

    {'1111'}    {'1111'}    {'1111'}    {'1111'}    {'1111'}
{'1111'}

  Columns 85 through 90

    {'1111'}    {'1111'}    {'1111'}    {'1111'}    {'1111'}
{'1111'}

  Columns 91 through 96

    {'1110'}    {'1110'}    {'1110'}    {'1110'}    {'1110'}
{'1110'}

  Columns 97 through 102

    {'1110'}    {'1110'}    {'1110'}    {'1110'}    {'1110'}
{'1101'}

  Columns 103 through 108

    {'1101'}    {'1101'}    {'1101'}    {'1101'}    {'1101'}
{'1101'}

  Columns 109 through 114

    {'1101'}    {'1101'}    {'1101'}    {'1101'}    {'1100'}
{'1100'}

  Columns 115 through 120

    {'1100'}    {'1100'}    {'1100'}    {'1100'}    {'1100'}
{'1100'}

  Columns 121 through 126

    {'1100'}    {'1100'}    {'1011'}    {'1011'}    {'1011'}
{'1011'}

  Columns 127 through 132
```

    {'1011'}   {'1011'}   {'1011'}   {'1011'}   {'1011'}
{'1011'}

 Columns 133 through 138

    {'1011'}   {'1011'}   {'1011'}   {'1010'}   {'1010'}
{'1010'}

 Columns 139 through 144

    {'1010'}   {'1010'}   {'1010'}   {'1010'}   {'1010'}
{'1010'}

 Columns 145 through 150

    {'1010'}   {'1010'}   {'1010'}   {'1010'}   {'1010'}
{'1010'}

 Columns 151 through 156

    {'1010'}   {'1010'}   {'1010'}   {'1010'}   {'1010'}
{'1010'}

 Columns 157 through 162

    {'1010'}   {'1010'}   {'1010'}   {'1010'}   {'1010'}
{'1010'}

 Columns 163 through 168

    {'1010'}   {'1010'}   {'1010'}   {'1010'}   {'1010'}
{'1010'}

 Columns 169 through 174

    {'1010'}   {'1010'}   {'1010'}   {'1010'}   {'1010'}
{'1010'}

 Columns 175 through 180

    {'1010'}   {'1010'}   {'1010'}   {'1010'}   {'1010'}
{'1010'}

 Columns 181 through 186

    {'1011'}   {'1011'}   {'1011'}   {'1011'}   {'1011'}
{'1011'}

 Columns 187 through 192

    {'1011'}   {'1011'}   {'1011'}   {'1011'}   {'1011'}
{'1011'}

```
  Columns 193 through 198

   {'1011'}    {'1100'}    {'1100'}    {'1100'}    {'1100'}
{'1100'}

  Columns 199 through 204

   {'1100'}    {'1100'}    {'1100'}    {'1100'}    {'1100'}
{'1100'}

  Columns 205 through 210

   {'1101'}    {'1101'}    {'1101'}    {'1101'}    {'1101'}
{'1101'}

  Columns 211 through 216

   {'1101'}    {'1101'}    {'1101'}    {'1101'}    {'1110'}
{'1110'}

  Columns 217 through 222

   {'1110'}    {'1110'}    {'1110'}    {'1110'}    {'1110'}
{'1110'}

  Columns 223 through 228

   {'1110'}    {'1110'}    {'1110'}    {'1111'}    {'1111'}
{'1111'}

  Columns 229 through 234

   {'1111'}    {'1111'}    {'1111'}    {'1111'}    {'1111'}
{'1111'}

  Columns 235 through 240

   {'1111'}    {'1111'}    {'1111'}    {'1111'}    {'1111'}
{'1111'}

  Columns 241 through 246

   {'1111'}    {'1111'}    {'1111'}    {'1111'}    {'1111'}
{'1111'}

  Columns 247 through 252

   {'1111'}    {'1111'}    {'1111'}    {'1111'}    {'1111'}
{'1111'}

  Columns 253 through 258

   {'1111'}    {'1111'}    {'1111'}    {'1111'}    {'1111'}
{'1111'}
```

Columns 259 through 264

{'1111'}   {'1111'}   {'1111'}   {'1111'}   {'1111'}
{'1111'}

Columns 265 through 270

{'1111'}   {'1111'}   {'1110'}   {'1110'}   {'1110'}
{'1110'}

Columns 271 through 276

{'1110'}   {'1110'}   {'1110'}   {'1101'}   {'1101'}
{'1101'}

Columns 277 through 282

{'1101'}   {'1101'}   {'1100'}   {'1100'}   {'1100'}
{'1100'}

Columns 283 through 288

{'1100'}   {'1011'}   {'1011'}   {'1011'}   {'1011'}
{'1010'}

Columns 289 through 294

{'1010'}   {'1010'}   {'1001'}   {'1001'}   {'1001'}
{'1000'}

Columns 295 through 300

{'1000'}   {'1000'}   {'0111'}   {'0111'}   {'0111'}
{'0110'}
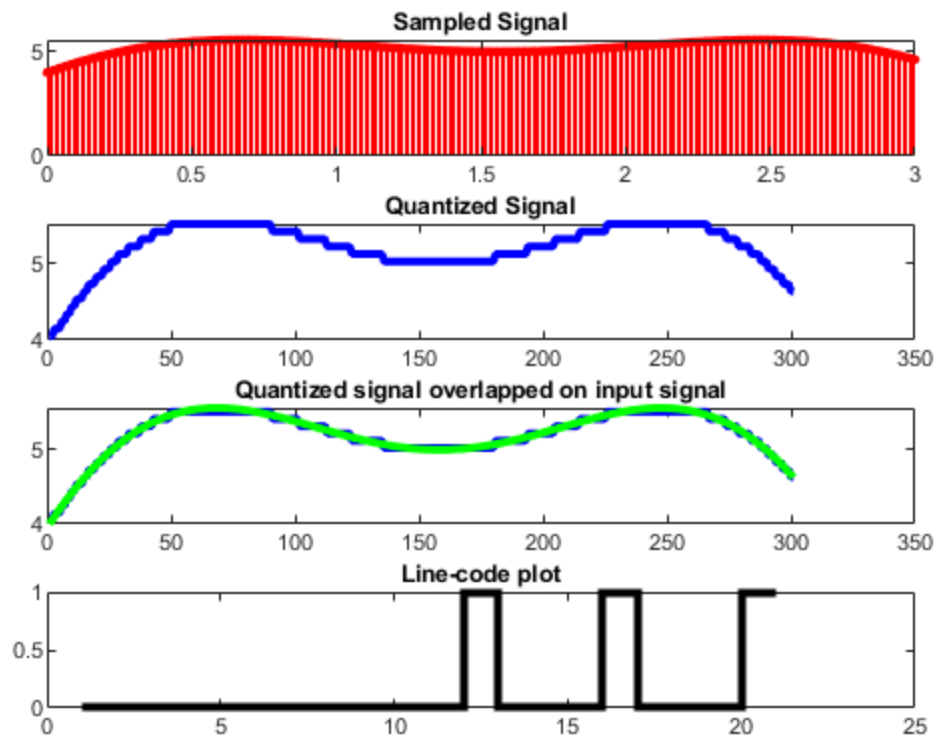
Column 301

{'0110'}

Current plot held
Bitstream is given below
00000000001000100010010001000110011010001000101010101010110011001110111001110111100010
Length of bitstream is
1204

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